

SOCIAL DYNAMICS OF MOUNTAIN GOATS IN SUMMER:  
IMPLICATIONS FOR AGE RATIOS

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ABSTRACT

Sex-age compositions of mountain goat (*Oreamnos americanus*) groups on Mount Evans, Colorado, were determined during late-summer, 1981. Eighty-four percent of observed groups contained kids and/or yearlings. Groups without kids or yearlings were composed exclusively of adult and/or 2-year-old males. Few adult males were observed using alpine tundra habitats during late-summer. Because adult males are less observable, kid:yearling:adult ratios are biased and tend to overestimate the proportions of kids and yearlings in populations. Implications of these findings for population estimation and modeling are discussed. Recommendations for standardizing methods of obtaining age ratios are given.

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INTRODUCTION

Mountain goat age ratios have been used as indicators of reproductive success and kid survival, and to evaluate population trends. In addition, age ratios are used in setting harvest rates for some goat populations. However, because mountain goats are not sexually dimorphic, classification is often difficult. Consequently, goat age ratios are often reported as either kids per adult or kids per older animal instead of as kids per adult female, as with other ungulates. To our knowledge, the validity of mountain goat age ratios as indicators of reproductive success has not been examined.

Objectives of this paper are to: (1) present data on late-summer group composition of mountain goats on Mount Evans, and (2) examine the accuracy of age ratios as indicators of reproductive success of mountain goats.

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#### METHODS

Ground surveys, initiated from the Mount Evans road (Colorado Highway 5), were conducted on 9 days from 30 July to 19 August, 1981, to locate and classify mountain goats. Despite being a hunted population, goats on Mount Evans have become habituated to the presence of humans due to the amount of human activity on and near the Mount Evans road. This relative "tameness" provided an unusual opportunity to approach and observe goats at close range (often <15m). From such distances it was possible to determine the exact sex-age composition of all groups observed. Goats were classified as kids, yearlings by sex, 2-year-olds by sex, or as adults by sex using horn characteristics, urination postures, external genitalia, and nanny-kid associations (Brandborg 1955).

Group composition data were compared with sex-age ratios derived from a 1-day intensive ground survey of Mount Evans conducted by Colorado Division of Wildlife personnel on 21 July, 1981. For this survey, goats were classified as kids, yearlings, older animals (either yearlings or adults) or as adults (males, females, or unclassified).

When goats were observed, the date, time, location, group size and composition, group activity, and habitat type were recorded on standard observation forms. Goats were considered within the same group if they were in visual contact and < 50 m apart.

#### RESULTS

A total of 118 goats was observed from 12 walking routes during an intensive 1-day ground survey of alpine tundra habitats on Mount Evans on 21 July, 1981 (Table 1). Assuming the age ratio in 11 "older" goats was the same as the ratio in 72 classified yearlings and adults, the observed kid:yearling:adult ratio was 57:36:100. The observed kid: older goat ratio was 42:100.

Of the 64 groups observed during the 9 days of ground surveys, 84% contained either kid and/or yearling goats (Figure 1). All adult and 2-year-old females observed were in groups containing either kid and/or yearling goats. Thirty-seven percent of observed nanny-juvenile groups contained mature males. Groups without kids or yearlings were composed exclusively of adult and/or 2-year-old males. Nine of 10 observed groups composed of adult and/or 2-year-old males contained 2 or fewer goats, and 74% of all adult and 2-year-old males observed using alpine tundra habitats were in groups of 5 or less individuals (Figure 2). Nanny-juvenile groups (averaging 6.4 individuals) were significantly ( $P < 0.001$ ) larger than were male-only groups (averaging 1.6 individuals).

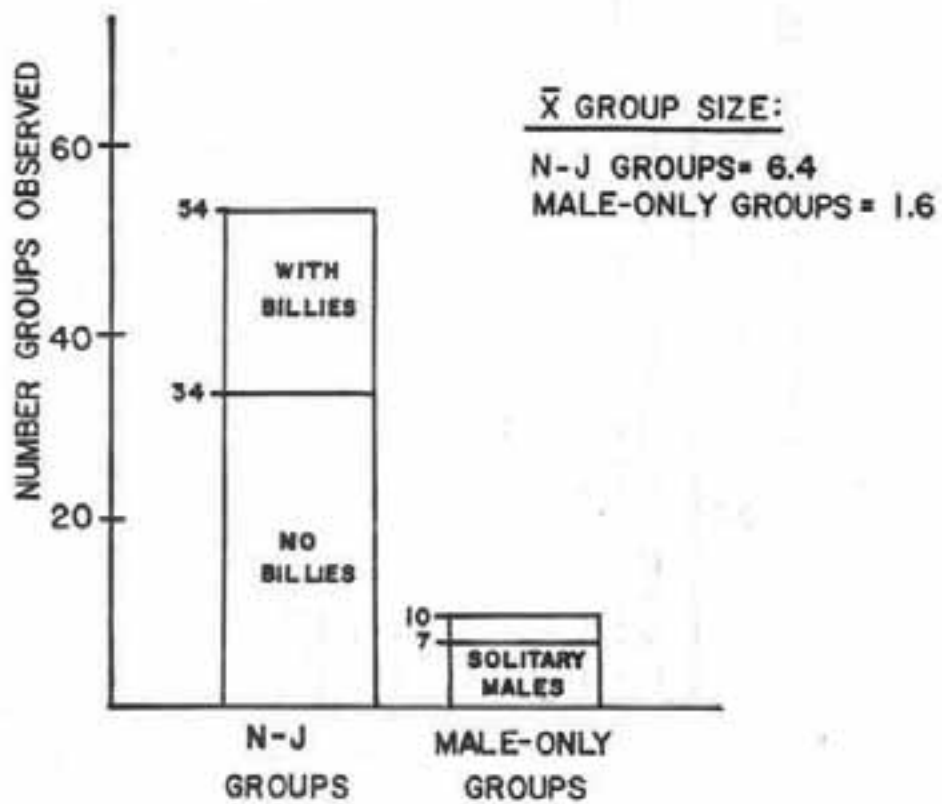


Figure 1. Composition of 64 mountain goat groups observed using alpine tundra habitats on Mount Evans during 30 July - 19 August, 1981.

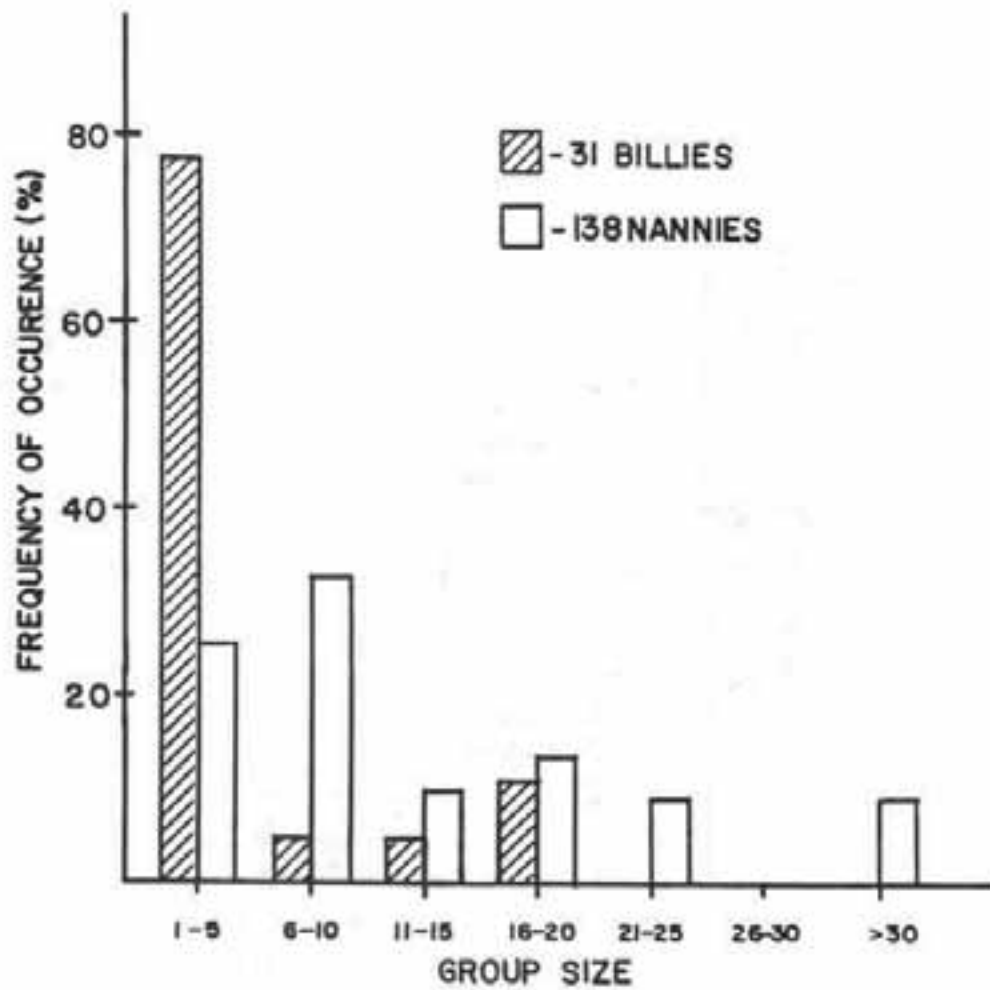


Figure 2. Frequency distribution of group size categories for adult and 2-year-old male, and female mountain goats observed using alpine tundra habitats on Mount Evans during 30 July - 19 August, 1981.

Table 1. Late-summer population structure of mountain goats using alpine tundra habitat on Mount Evans as determined from a 1-day intensive ground survey.

Goats Counted	Adult		Uncl. <sup>1</sup>	Older <sup>2</sup>	Yearlings	Kids
	Males	Females				
118	7	35	11	11	19	35

<sup>1</sup>Unc. = Unclassified.

<sup>2</sup>Older goats are either yearlings or adults.

Group composition data from the 9 days of ground surveys were pooled using the minimum population method (Geist 1971, Table 2). Although the population estimate obtained from this method (71 goats) was smaller, the kid:yearling: adult ratio (59:32:100) and the kid:older ratio (45:100) were very similar to results of the 1-day intensive ground survey. This suggests that both surveys were equally representative of the goats using alpine tundra habitats during this period.

Table 2. Sex-age composition of the known minimum population of mountain goats using alpine tundra habitats on Mount Evans during 30 July-19 August, 1981.

Known Minimum Population Size	Adults		2-Year-Old		Yearling		Kids
	Males	Females	Males	Females	Males	Females	
71	7	22	5	3	6	6	22

## DISCUSSION

### SOCIAL DYNAMICS

Chadwick (1977) hypothesized that, beginning at 2 years of age, male mountain goats occupy ranges peripheral to or separate from those of females and subadults. Such spatial separation minimizes competition between adult males and females and their offspring, and reduces the potential for injury to kids through interactions with adult males (Geist 1974, Chadwick 1977, Dane 1977, Singer 1977). In addition, adult male goats tend to occur in smaller groups during summer than do nannies and juveniles, and inhabit more rugged terrain where they are less observable (Geist 1974, 1978; Rideout 1975, Chadwick 1977, Masteller 1980, Adams 1981, Adams et al. 1982).

By forming large groups in open tundra habitats, nanny-juvenile groups may be better able to avoid predators. Although goats possess formidable horns, nannies with kids could be surprised by predators in forested habitats. In contrast, goats in large groups in open tundra habitat can

use mutual alertness and good visibility to detect predators at a distance and can move vulnerable offspring to secure terrain when necessary. Furthermore, preliminary analysis of data from Mount Evans (Risenhoover, in prep.) suggests that goats in larger groups were less antagonistic toward each other when compared to individual goats in smaller groups.

Gregariousness is a common mechanism in predator-evasion strategies of ungulates inhabiting open habitats (Walther 1969, Estes 1974, Bergerud 1974, Jarman 1974, Jarman and Jarman 1974, Bertram 1978, Risenhoover and Bailey 1980, Seigfried 1980). We hypothesize that nannies and juveniles become more gregarious on more open alpine tundra habitats during summer, when kids are small and vulnerable, at least partly to avoid predators. In contrast, mature billies avoid competition with nannies and juveniles by avoiding alpine tundra habitats and by occupying more rugged areas, often in more forested habitats. Billies which remain on alpine tundra ranges with nannies and juveniles are obliged to keep their distance from kids by frequent agonistic encounters with nannies (Risenhoover, in prep.) and as a result, tend to form small bachelor groups.

Assuming there is an 80:100 (male:female) sex ratio among adult goats on Mount Evans, approximately 62% of the adult males were unaccounted for during the 1-day intensive ground survey and during the other 9 field days. Such a sex ratio is not unreasonable since harvest data for Colorado (Adams 1981) indicate only a slight selection for male goats (58% of all harvested goats were males).

Geist (1964) also observed a low ratio of adult males to females in late September. However, the ratio of males to females increased from 10:100 in late September to 80:100 during the rut in November, supporting the premise that, during late summer, adult males occupy habitats other than those being utilized by nanny-juvenile groups.

#### IMPLICATIONS FOR AGE RATIOS

A variety of age ratios may be used as data on mountain goat populations depending upon opportunities for accurate sex-age classification. At one extreme, observers in fixed-wing aircraft may only classify goats as kids vs. older animals, especially in autumn when yearlings cannot be reliably distinguished from adults. With ground-based surveys in late summer, kid:yearling:adult ratios may be obtained from most Colorado populations. The opposite extreme is represented by this study in which habituated goats were observed from short distances and 7 sex-age classes were identified. However, few mountain goat populations are so accessible and habituated to people.

It is often tempting to survey populations in late summer because (1) yearlings can be distinguished from adults, even at a distance; and (2) because at least some populations exhibit large groups of goats on tundra during late summer, allowing large numbers of goats to be found and classified. However, this study supports Chadwick's (1977) hypothesis

concerning differential habitat use between adult male and female goats in summer. In addition, it appears that adult males are less observable than are nannies and juveniles, probably because they use more rugged terrain and/or forested habitats and because they tend to be in smaller groups. Masteller (1980), using ground surveys, found marked adult male goats were reobserved 0.32 times as often as were marked female goats during summer. As a result, sex-age ratios based upon summer classification counts are biased because adult males are under-represented, and kid:yearling:adult ratios will overestimate rates of production and recruitment. Likewise, if numbers of kids and yearlings in a goat herd are estimated by combining age ratios obtained in summer with a population census, these numbers will be overestimated.

Based on data from Geist (1964), more accurate age ratios might be obtained during the rut. However, at this time yearlings may not be distinguished from adults under some survey conditions. (Distinguishing yearlings from adults in autumn will be especially difficult if yearlings grow especially large. Exceptional yearling growth might be common in Colorado's introduced goat herds if they exist at low densities in relation to forage resources that were exploited little before goat introductions.) If only the pre-winter kid crop is to be estimated, kid:older animal ratios obtained in the rut should be considered. If the yearling crop is also to be estimated, an unbiased prediction might result if a kid:yearling ratio is obtained in late summer and a kid:older animal ratio is obtained during the rut. If one assumes the ratio of kids:yearlings is stable during summer to the rutting period, the number of yearlings classed as older animals during the rutting season can be estimated from the late-summer ratio. These possibilities deserve additional research.

An alternative for estimating rates of production and recruitment is, of course, to classify adults as nannies or billies and use kid:yearling:nanny ratios. However, we have been unable to classify all adults by sex under most survey conditions in Colorado.

Age ratios may also be used as indices to trends in rates of reproduction or recruitment. In this procedure, biased age ratios will not produce inaccurate trends so long as biases are consistent over time. Consequently, age ratios obtained in summer may be used to detect trends over years or to detect differences among years with different weather conditions if the same proportion of the adult males in the population can be classified each year. Standardizing the survey method would support this goal. Surveys should be conducted during the same time of year and under the same weather conditions. Observer effort should remain constant among years, as extra effort in some years may result in the location and classification of extra adult male goats. Using fixed survey routes would be a way to control this source of bias.

#### CENSUS

Lincoln-Petersen censuses require either animals be marked at random or that a later random sample be obtained to estimate the proportion of marked

animals in the population. If adult males are not properly represented in a marked sample of mountain goats, a late-summer sample of the population marked:unmarked ratio will be biased if, as suggested here, males are less observable than are females. Solutions to this problem are (1) mark males and females in proportion to their occurrence in the population, or (2) perhaps a random sample of the population marked:unmarked ratio can be obtained during the rutting season.

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## CONFERENCE DISCUSSION

Comment - Just a couple of comments instead of questions. Because a previous paper involved detailed age ratios, I'm not sure that it was always clear that we're talking about implications for age ratios taken largely from aircraft. You're not able to identify males and females so that the biases you are talking about are biases when you are calculating kid ratios and the males are unrepresented. Secondly, with respect to the adaptive strategy of large groups on open tundra at that time of year, maybe something we've overlooked here is that during this season metabolic requirements are extremely high, especially for the reproducing segment of the herd. Kids have high metabolic requirements as do lactating nannies. It also may be important to put on a lot of tissue in order to get through the next winter, and what may be going on here is that the animals simply cannot find enough high quality forage in a high enough density if they stay in the cliffs. So, they have to get out where they can forage efficiently, out of the cliffs, and the only way, as you say, they can do this safely is to form these large groups.

Q. The survey of Mount Evans in 1981 produced an unbalanced sex ratio. How about the survey that was done in 1980? I know that surveys have been done on Mt. Evans in 1980 and maybe 1979. Are they also exhibiting this unbalanced male sex ratio?

Ans. In most cases, adult goats were not classified by sex during those surveys.

Comment - I think its entirely possible to sex goats out of aircraft, certainly out of a helicopter.

Comment - I have a comment on the problem of sexing goats from aircraft in Colorado. One of the problems we have is with large groups away from escape terrain. If you fly over, even if your are in a helicopter, you fly over 40 goats in open terrain. They run instead of stopping like they do on cliffs. And what they do on rough terrain is spread out all over, or run into trees.